

**Department of Conservation
California Abandoned Mine Lands Forum
801 K Street
Sacramento, CA 95814**

**May 19, 2004
Meeting Notes**

Facilitator: Chris Harris, Harris and Company

Meeting Summary: Chris Harris, Harris and Company

Attendees:

Dustin Bambil, LWA
Abe Beagles, California Nevada Water Quality
Ron Churchill, Department of Conservation
Janine Clayton, US Forest Service
Doug Craig, Department of Conservation
Richard Grabowski, Bureau of Land Management/CASO
Sam Hayashi, Department of Conservation
Chris Harris, Harris & Company
Rick Humphreys, SWRCB
Darcy Jones, State Water Resources Control Board
Randy Kirby, Shaw Environmental
Shelby Lathrop, Shaw Environmental
David Lawler, BLM/AML
G. Fred Lee, G. Fred Lee Associates
Vicki Murphy, Cache Creek
Donna Podger, CALFED Bay-Delta Program
Alberto Pujol, MWH
Sarah Reeves, Department of Conservation
Greg Reller, Tetra Tech
Michael Sawlan, National Bank Service
Heather M. Smith, Department of Conservation
Mark Springer, Bureau of Land Management/CASO
Becky Wood, Teichert

Agenda:

- I. Welcome, Introductions, and Agenda Review
- II. Presentations
- III. Announcements
- IV. Next Meeting

Meeting:

I. Welcome, Introductions, and Agenda Review

Chris Harris welcomed AML Forum attendees. Meeting participants introduced themselves. The agenda was reviewed and no changes were made. Chris asked that, in the “Announcements” part of the meeting, participants primarily give updates on projects that they haven’t already reported to other groups such as DTMC and STAMLAG.

II. Presentations: Assessment of Mercury Contributions from Historic Mercury and Gold Mine Sites in the Sulfur Creek Mining District to the Cache Creek Watershed, by Ronald Churchill, California Department of Conservation, California Geological Survey

Ron Churchill presented his study of the above title to the AML Forum. Ron and John Clinkenbeard worked on this study, funded by CalFed, to look at historic mines sites, try to determine what contribution of mercury to the water system these mine sites are making, and ultimately, make suggestions on approaches to remediation.

Ron showed a map of the Cache Creek Watershed and highlighted mine sites, watersheds, streams, USGS gauge stations, springs and locations where background samples were taken. He said that three mining districts are located within this large watershed: Sulfur Creek Mining District, Sulfur Bank Mining District, and McLaughlin Mining District – also called the Knoxville. Ron said that the 1870s were big time for mercury mining, but that after 1971, no mercury production occurred in the Sulfur Creek Mining District.

The study covered:

- Types of mercury-containing materials at mine sites.
- Mercury content by material type.
- Mercury mobility during weathering by material type.
- Mechanism of mercury transport from mine sites to waterways.
- Rate of mercury movement from mine sites.
- Remediation approaches.
- Other non-mining related site mercury containing materials.
- Mine site mercury contributions vs. non-mine mercury contributions to waterways.
- Future study suggestions.

Ron showed a series of photos of mines within the Sulphur Creek Mining District, including Abbott Mine/Turkey Run mine.

Q. Donna Podger asked for clarification of where the waterway is with respect to the Abbott mine site.

A. Ron showed where it was: A ditch along the north side of Highway 20 that runs to Turkey Run, under Highway 20 through a box culvert, and into a small wetlands. He pointed out that there is no permanent water here. However, there is some thermal water flows that comes from a collapsed adit at the Turkey Run mine site. The ditch water below the Turkey Run contains a lot of sulfur but not much mercury.

Q. Fred Lee asked if Ron had investigated the wetland for sources of methylation.

A. Ron said no. That would be a good location for someone to do a detailed mercury methylation study.

Ron showed a series of photos that illustrated different material types that could contain mercury, including:

- stream bank erosion undercutting a pile of calcined tailings
- waste rock from underground mining
- mercury-enriched bedrock in surface cuts and benches, subject to erosion

He showed the proximity of waterways to each of these material sources and explained how mercury could be transported into them. Most of the calcined tailings in the mining district are located at the Abbott mine site. Much smaller quantities of calcined tailings are present at the mine sites near Wilbur Springs and not all of those sites have discrete calcined tailings piles. In some cases, this material was likely put into Sulphur Creek and transported downstream from the mine site during winter storm events, so it is no longer present at the mine sites.

Ron told the AML Forum that naturally occurring mercury in the environment can be measured at quite high levels. For example, at the Manzanita site, Ron saw mercury levels at 390 ppm in local mine-site background soil (apparently undisturbed by mining activity).

Q. Fred Lee asked: How is mercury distributed in the natural environment near the mine sites?

A. Ron said it is distributed in small vein structures that permeate the rock.

Ron continued his presentation by showing photos of a historic ore handling and truck loading structure at the Turkey Run Mine. He said there is active gully erosion of mine waste rock and calcined tailings used as road and pad covering at this site. He said that in the mining days, ore would be taken from underground to the surface at Turkey Run and then loaded onto trucks and hauled to the Abbott mine site for processing and mercury recovery. Thermal springs water intersected by the Abbott-Turkey Run underground workings reaches the surface through a collapsed adit at the Turkey Run site. This water interacts with the elevated mercury materials at this site and relatively high concentrations of methyl mercury have been documented here (by Jim Rytuba-USGS).

Q. Fred Lee asked: Is methylation occurring without anaerobic conditions?

A. Apparently the methylation is occurring very near the water surface (because the water depth is mostly only a few inches in this wetland and may be less reducing than at some

other sites. It is probably still a reducing environment. This would be a good site at which to study methylation processes). Ron added that the thermal spring is high in sulfur and that it would be interesting to study the impact of this sulfur on methylation activity here.

Ron continued by showing a photograph of a rotary furnace mercury processing site at the Abbott Mine. He said that the rotary furnace was the state of the art mercury furnace in the 1900s. He showed a retort, a smaller and simpler means of vaporizing mercury that was just a box with pipes near the Wilbur Springs. He summarized that he and his study partner John Clinkenbeard looked at many different types of mine materials and analyzed them for mercury content by mine material type.

Q. Doug Craig asked if all types of background levels of mercury were addressed, including atmospheric?

A. Ron said atmospheric contributions were not studied directly, only mercury from local soils and the contribution from parent rock. Some information on atmospheric mercury contributions are available from work by other people and will be summarized later in the presentation.

Ron presented a series of figures that showed the results of leaching mercury from various mine material types (e.g., calcined tailings, waste rock, ore, and soils around processing equipment.) He said this gives a qualitative sense of material movement based on the weathering principle. The results of this leaching analysis were:

- Most mercury is present as relatively insoluble HgS minerals except for in processing site soils.
- A relatively small component of more mobile / reactive mercury is present in these materials.
- Most mercury probably moves from mine sites to waterways in the particulate form.

Ron talked to the AML Forum about the next part of his study that addressed: Erosion Estimates of Mine site Materials Using the Revised Universal Soil Loss Equation (RUSLE). He said that RUSLE is a USDA empirical model used successfully to predict erosion at mining sites. It has been used at the Homestake mine site during the permitting process. RUSLE has a track record of being intuitive and relatively simple to use.

Key questions to answer are: How are these piles eroding and what amounts of material are coming off? To answer this, he applied the RUSLE. He said there are limitations:

- Limited to rill and interrill erosion (not ephemeral gully erosion)
- Should not be applied to slope lengths of more than 1000 feet
- Unsuitable for modeling erosion for individual storm events.

RUSLE incorporates factors for temperature, rainfall, slope steepness and length, soil type and vegetation coverage.

Q. Rick Humphreys asked: Does RUSLE handle slope failures?

A. No.

Ron showed a slide with the following equation to determine annual mercury contributions by erosion from mine sites to watersheds:

$$\text{Annual mercury contribution}^* = \text{Estimated annual contribution (kg)} \times \text{Hg (ppm)} \times 10^{-6}$$

* Determined for each mine site feature (e.g., pile, cut slope); totals compiled by mine site and by watershed

Ron showed a slide with the estimated average annual mercury delivery from mine sites to the Cache Creek Watershed.

Harley Gulch = 1.2 – 10.2 kg

Sulphur Creek = 4.4 – 18.6 kg

Bear Creek = 1.2 – 24.3 kg *(delivered to dry ravines next to mines; uncertain if any reaches Bear Creek)*

- Q. One person asked about any measurements of mercury contributions from current industry uses.
- A. Ron said that a significant amount of mercury in waterways is probably from historic mining activity and a portion would be from background (natural) conditions. He said we don't have good handle on percentages from industry use of mercury.
- Q. Another person asked: Does your study show if there is much mercury around mine sites?
- A. Ron said that the study shows that even prior to mining activity, weathering and erosion of the naturally elevated mercury soils at these sites would have been contributing mercury to the watershed.
- Q. Fred Lee asked if 90% of the movement of mercury takes place during storm event.
- A. Yes.

Ron then summarized this part of the presentation. He said:

- Mine materials, calcined tailings and waste rock, have generally similar mercury concentrations. Ore is the exception—it is higher but there is not much of it .
- Only a small amount of the total mercury in mine materials is relatively mobile by leaching during weathering. Processing site soil appears to be an exception.
- Mercury contributed annually to Sulphur Creek and Harley Gulch by erosion of mine site materials is estimated in the Kg to several 10s of Kg range.
- Acid mine drainage was not observed.
- Gold recovery is unlikely to be a reclamation incentive.

- Erosion control is likely to be the most important reclamation approach because mercury is mainly transported from mine sites in particulate form.

Ron continued his presentation by discussing other mercury sources: naturally enriched mercury soil, mercury in thermal springs, natural background mercury in soil, elevated mercury in stream sediments, and atmospheric mercury. He showed a series of photographs including springs and streams with evidence of precipitated sulfur, and showing other precipitates containing mercury.

Q. Fred Lee asked if one of Ron's photographs showed iron sulfides (Blank Hot Spring)?

- A. Ron said that the black precipitate it showed contains silica, sulfide and significant amounts of mercury and other heavy metals. He said that the mercury is probably pretty readily available, but we don't know what the mercury contribution is to the watershed because we don't know the quantity of precipitates produced annually.

Ron showed a table of the background mercury content in natural formations (serpentine, Great Valley and Franciscan formations). He explained the significance of regional background levels of mercury using an example of the Prospect Slough. Total mercury loads entering the watershed from the study area based on work by the USGS and UC Davis for an 18-month period (including material transported from mine sites and thermal springs) were less than 5 Kg (less than 6%) of the Prospect Slough 18-month mercury load estimate (75.59 Kg) made by Chris Foe at the Regional Board. Ron said that 38 to 57% of the Prospect Slough mercury load appears to be related to erosion of material with natural background mercury levels.

He looked at background mercury levels, which were 28 – 45 Kg Hg. His study asked: Where did the remaining 27 to 42 Kg of mercury come from? Ron showed a diagram of "sources and fate of mercury in the Sulphur Creek Mining District". He said that the remaining mercury is probably from sediments but researchers need more information on this. Other studies show 10 - 20 ppm Hg in sediments in Sulphur Creek below Wilbur Springs.

Future studies should investigate:

- Study of elevated mercury sediment deposits along streams.
- Thermal spring precipitates.
- Naturally elevated mercury in soil.
- Mercury emissions to the atmosphere from elevated mercury in soil.
- Atmospheric mercury deposition.

Q. Fred Lee said he is involved in the superfund site at UC Davis. He asked if the whole area of Davis would be high in Hg during storms? If fact, he wonders if whole Putah Creek basin is high in mercury?

- A. Ron said mercury in the Putah Creek basin may be an emerging problem that we're just now getting a handle on.

Q. Donna Podger asked about considering high-end storm events instead of averages?

- A. Ron said he didn't think it was feasible to try and model single storm events and RUSLE cannot be used for that. He said there might be people who could model individual storm

events, but he did not do that. There are some on-site research projects that might provide additional useful insights regarding erosion during storm events. One could mimic a hard rainstorm with sprinklers and quantitatively measure the resulting material transport and get very useful results, but he is leery of pure computer modeling.

Q. Rick Humphreys said that storm events affect everything, not just mercury.

A. Ron agreed and said that even 1/10th of an inch of rain from a storm could be significant.

Fred Lee said that storm events affect the Bay; not just local waterways.

Q. Abe Beagles asked Ron if he had a handle on the water in summer months at Highway 20.

A. Ron said that whatever is in the water is coming from the thermal spring that exits through the mine workings at Turkey Run.

Q. Abe commented that if sulfur is removed from that spring water, then it would take away the microbes. He asked how many gallons of water drains at Highway 20 in the winter.

A. Ron said he didn't recall the amount. That information is in the UC Davis study.

Q. Fred Lee asked about other metals and radioactivity.

A. Ron said there are other metals present at the mine sites as a result of the mineralization activity related to the mercury deposit formation. He said they are not being pursued as heavily as mercury right now.

Q. Vicki Murphy referred to Chris Foe's presentation to the DTMC on clams transplanted from one environment to another with different levels of mercury. She said that the environment of Clear Lake is high in chlorophyll.

A. Ron said that her observations point out the complexity of the mercury methylation issue. He said that conditions that govern mercury methylation in one area might not be the same in another.

Fred Lee asked the group whether we ready to spend \$100 million to fix the mercury situation?

Q. Becky Woods asked if Ron did any analysis of the size of mercury-containing materials.

A. He said he has some information but did not write it up in the study.

Second Presentation: Control of Contamination from Inactive Mines, by Gregory Reller, Tetra Tech EM Inc.

Greg Reller presented his study of the control of contamination from inactive mines to the AML Forum. His presentation covered these main topics:

- Selection of controls
- Examples of controls

- Costs

When selecting methods to control mercury contamination from inactive mines, Greg began with identifying site features that require mediation. He showed a series of maps and photos of features related to the Abbott Mine, Turkey Run, and the west fork of Harley Gulch. He said that you have to look at the mine up close to be able to determine *how* to fix the mercury contamination problem.

In the photos, Greg pointed out potential sources of mercury: the diversion of Glory hole gulch which now cuts through piles of waste rock, and landslides that will likely eventually move into mine waste.

An engineering evaluation of potential controls includes:

- Identifying a complete pathway (e.g., erosion and transport of tailings into surface water).
- Screening potential remedial alternatives: surface controls, off-site disposal, on-site isolation, treatment, and re-mining.
- Evaluating the implementability, effectiveness, and cost of the alternative methods.

He showed an example of a project – Leviathan Creek – where surface controls reduced mercury levels by 80% in the 1990s.

Greg showed a table of control alternatives that are applicable to various types of rocks and soil. The table related general response action to technology type and alternative control methods. He gave an example of what he would consider in the engineering evaluation:

<u>Implementability:</u>	Availability, compliance with regulations, community acceptance, and regulatory acceptance.
<u>Effectiveness:</u>	Short-term effectiveness, long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; overall reduction of mercury load and protection of water quality.
<u>Cost:</u>	Cost.

Greg said one of the more important elements of the evaluation is whether or not the controls will meet regulations. If not, the control methods would be wasted dollars. Other important questions are: Does it meet with community expectations? Will it work?

Greg made two points about cost:

1. Don't look at the cheapest control first. Look at effectiveness first.
2. Do a present-worth analysis because you have to consider capital costs and O + M costs.

Q. Fred Lee said that when looking at just a 30-year period, the cost can be grossly underestimated. He said that if you consider the true long-term costs – which could perhaps occur over 100 years – estimating for a 30 year period may not be accurate.

A. You look at the longer periods like 100 years when it's the reflection of the true fix. There are ways to estimate those longer costs.

Q. Fred Lee noted that EPA wants to dump Lava Cap on the State after 30 years.

A. Greg said that is a statutory requirement.

Greg discussed alternative remedies to control mercury from the Abbott tailings. They included:

Box Culvert	\$260 K	
On site repository	\$3.9M	
Surface controls	\$50K	
Demolish and dispose of infrastructure offsite	\$212 K	(This alternative would get rid of attractive nuisance.)

He talked about different surface controls:

- Big pipes isolate runoff from mine waste. Sometimes the pipe can be hidden.
- Straw wattles are comparatively inexpensive at \$1/foot plus labor. Within 2 ½ years, voluntary revegetation takes over. The straw wattles work by first slowing down sheet flows. This allows seeds to take root and naturally stop erosion.
- Rice Straw is also an inexpensive option at \$565/acre. This control method would work in environments that are not aquatic (the concern is not to introduce alien species).
- The demolition of the ore furnace (equipment) involves pushing it over, cutting it up and hauling the demolished material away for disposal. The cost to decontaminate the old equipment is too high to consider. Disposal costs run around \$75/ton. Demolition is about \$3,250/day.

Q. Doug Craig asked if Greg encountered any historic preservation issues.

A. Yes. His group surveyed and photographed the site for historic preservation. He said that in another site, his group left structures in place to protect a bat colony.

Q. Richard Grabowski asked: Did you wash equipment before disposal?

A: No. They inspected the demolished material but did not have to decontaminate. It had been sitting in the sun for 50-70 years. Mercury vaporizes at a low temperature. Also miners worked hard to get all the mercury they could and didn't waste a lot.

Greg showed photos of excavation where tailings are lifted into trucks, into bins, and sampled for profiling. The least expensive, effective control method for the site Greg showed was to take material offsite.

He also showed how to build a repository on site.

- Site preparation involves stripping the top soil and saving it to cover final repository. In the stream restoration project that Greg described, the cost was \$12.50/ cubic yard.
- The next steps were placing a GCL liner at a cost of \$11.10 / square yard and a leachate control and removal system.
- Next, crews placed excavated tailings put on top of liner.
- A repository cap was placed on top of that at a cost of \$10.55 / square yard.
- A layer of GCL is then placed on top on top and the previously excavated top soil replaced on top of the GCL.

Q. Doug Craig asked: What was total cost of the stream restoration project?

A. \$1.25 million including design and construction. Stream restoration cost \$12.50 per linear foot and mulch and revegetation cost \$1,150 / acre. It was funded by the State of Montana. The San Jose State University foundation, through CalFed SETA, did the Cache Creek work.

Q. Dustin Bambil asked: Is monitoring required?

A: Yes, for rills, leachate, groundwater, and vegetation.

III. Announcements

Dave Lawler, BLM/AML and Janine Clayton, USFS said the San Luis Obispo project is estimated to cost \$2.2 million. The operation of moving dirt begins in August, in 8 weeks. The project involves two small retorts. They are going back next week to do systematic leachate work.

Dave said AML is starting a more intensive investigation of the Oathill mine. This mine is in the middle Putah Creek Watershed. They will be taking samples of sediments and the tailings pile.

Janine Clayton reported that EPA is the lead agency investigating the Rinconada site. Work is progressing, including some physical closures. She distributed *Stay Out and Stay Alive* DVDs to everyone. She also said that a one-day training session on confined space will be offered on July 23rd in Davis by the UC Davis Extension. To take the course, people should contact the UCD Extension office.

Donna Podger, CalFed reported that the date for her agency to publicize Requests For Proposals for mining remediation has been pushed back again. There will be around \$15 million in Prop 50 funds for projects that affect Bay Delta water quality. The RFPs should come out in winter. Donna's group tried but could not get the okay for concept proposals. CalFed will require full proposals. She reminded the AML Forum that the best way to be informed of grant opportunities is to go to the main CalFed website and sign up.

Doug Craig, DOC/AML told the group that the AML forum is sponsored by the Bay Delta Authority and that we are all grateful for this support. He reported on several activities including:

- Geophysical work being done at the Walker Mine will address the problem of surface water flow into the collapsed mine workings.
- A bat gating project in Imperial County will have to wait until after roosting season before work can continue (sometime in the fall).
- DOC / AML unit is committed to partnerships with other groups. They participated in 23 partnerships last year and 12 so far this year.
- One way to extend DOC's budgets is to partner. This year, the administration proposed \$180,000 for physical hazard remediation work. Not only was this supported, but the Senate subcommittee increased the amount to \$400,000. Doug encouraged AML Forum partners to consider this source of funding and look for projects for us. Such partnerships enable the AMLU to extend the scope of their work.
- The AML unit is in the early stages of creating an on-line application form to propose physical hazard remediation projects.

Janine Clayton asked about the status of State's database of abandoned mines. Doug said that it's growing and that the AML is trying to partner with Plumas National Forest so that their abandoned mine information could go directly to database. **Vicki Murphy, Cache Creek Watershed** said she sees a lot of conflict within watershed. She expressed concern about not being able to get into Cache Creek to prevent erosion. She believes that there are many simple things that could be done to minimize mercury problems in the watershed but progress is slow and the obstructions are many. She talked about the need for wilderness designation in Upper Cache Creek. She believes that TMDL's won't do anything to stop degradation to water ecosystems. Vicki has cattle ranch with three canyons that flow into the watershed. One would be good candidate for reservoir, which could help control sediments, but she isn't allowed to build it. She said that she believed most mercury concern is for fish and not human health issues.

Alberto Pujol, MWH told the group about an article in the Sacramento Bee about new dam at Iron Mountain mine. The project was completed and filled for testing purposes.

Fred Lee, G. Fred Lee Associates, said that EPA Region 9 recently released a newsletter about the Iron Mine. He will tell the group how we can get on the list.

Donna Podger asked about the status of the legal liability issue. Doug said that a work product from the legal working group should be available soon. Donna suggested that we put this item on the AML Forum agenda for August 2004.

IV. Next Meeting:

August 11, 2004

9 a.m. - Noon

John Muir Conference Room
801 K Street, 20th Floor
Sacramento, Ca. 95814